SPATIAL PATTERNS AND DETERMINANTS OF CAMPYLOBACTERIOSIS IN THE CZECH REPUBLIC

Lukas MAREK
Department of Geography & Geospatial Research Institute
University of Canterbury, Christchurch, New Zealand
lukas.marek@canterbury.ac.nz

INTRODUCTION AND DATA

Campylobacteriosis, although not as well-known to the general public as other gastrointestinal illnesses, is the leading cause of gastroenteritis in developed countries. Its aetiology is still described rather partially with links to poultry meat, pets, fresh milk and dairy products, and the environment. Due to its character with often minor symptoms, the infection is also highly underreported. The research explores patterns of the disease in the Czech Republic between 2008 and 2012 taking into account its spatial and temporal distributions, and searching for the differences in the attribute space covering demography, socio-economic characteristics, and environment.

Using spatial correlations of individual determinants in combination with multivariate (spatial) techniques, and artificial neural networks, municipalities in the Czech Republic were clustered into seven groups. Individual groups are described by mean, median and standard deviation of its characteristics and depicted with similar municipalities in both, dendrogram and geovisualisation. Characteristics of five of identified groups change rather gradually, while the characteristics of two groups are relatively dissimilar to others. Groups express the vulnerability of individual municipalities to the occurrence of campylobacteriosis providing the localised information. Areas of the lowest vulnerability are represented mainly by small municipalities in less populated areas (e.g. in highlands). They also create spatially continuous clusters. Low vulnerability to Campylobacteriosis is found in municipalities that are more densely populated. Municipalities with an increased vulnerability to the disease are located in eastern part of the Czech Republic (NE Moravia and Silesia), around the second most populated city (Brno) and in South Bohemia.

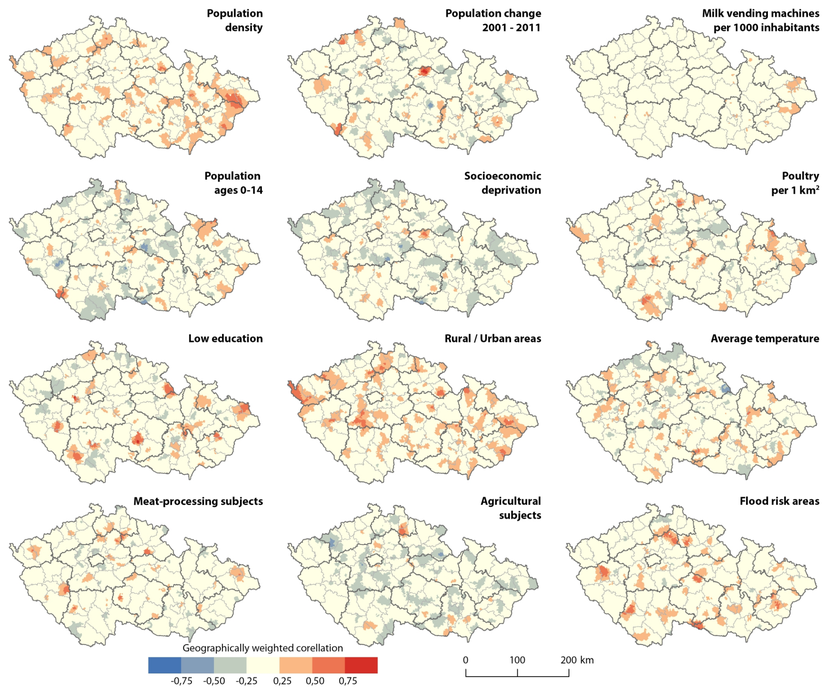

Fig. 1 Local correlations of selected municipalities' characteristics and relative risk of campylobacteriosis

CLUSTERING USING SELF-ORGANIZING MAPS

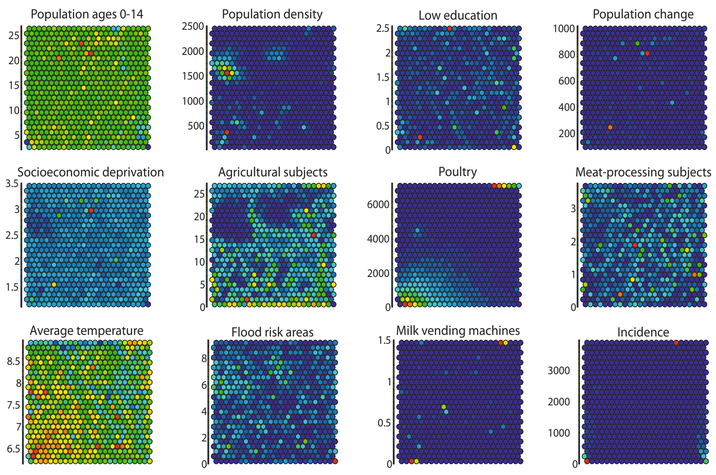

Fig. 2 Data aggregated to individual heatmaps entering SOM

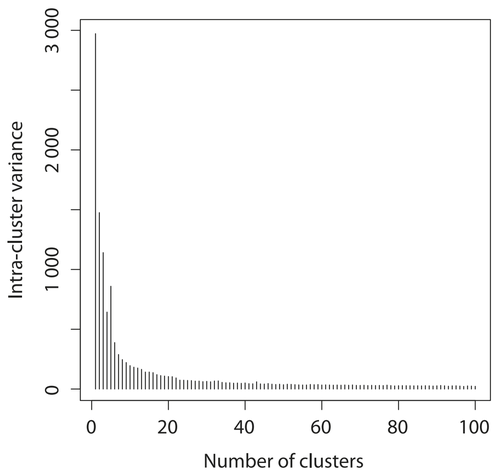

Fig. 3 Scree plot helping to evaluate a suitable number of clusters

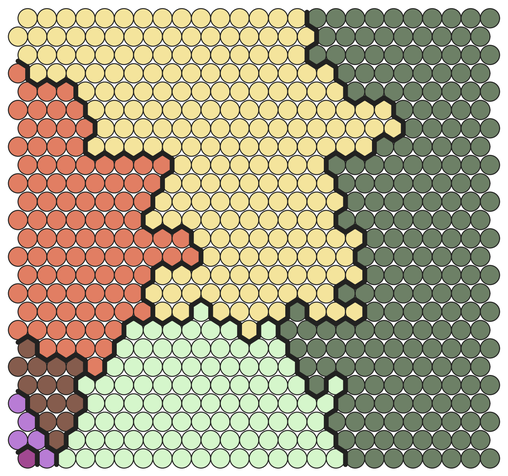

Fig. 4 Visualisation of SOM clusters in 2D space

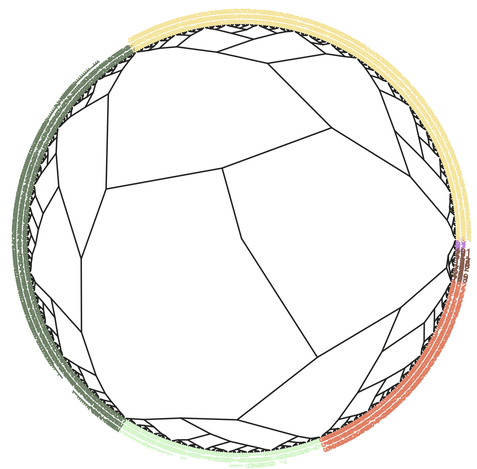

Fig. 5 Dendrogram of clusters visualising similar municipalities.

RESULTS

Group 1 (dark green colour in the map and graph, 2672 municipalities/12.88% of the population in the Czech Republic) covers an area with the lowest risk/vulnerability to campylobacteriosis. It consists of municipalities where the occurrence of the disease is rare. Most of characteristics are in their mean levels comparing to overall values for the entire state. An exception is an above average ratio of agricultural business subjects, and lower mean air temperature, which is an exceptional combination of characteristics. The group is consisting mostly of municipalities with the lowest population density.

Group 2 (light green colour, 691 mun./21.51%) covers the municipalities with the low relative risk for campylobacteriosis. These are municipalities with the highest population density, and also with the highest ration of children (0-14 years), and the highest average temperature. Due to the high temperatures, there is also a high number of agricultural businesses, and the highest estimated counts of poultry to the area of the municipality. In this group, the population increases by 15% in 10 years.

Group 3 (light yellow colour, 1942 mun./37.18%) are made of municipalities with an average relative risk / vulnerability to the disease. Most of characteristics are in their mean level with an exception of the second highest ration of children in the population.

Group 4 (light red, 875 mun./27.69%) consists of densely populated municipalities with slightly increased risk for the disease. However, the mean number of individual cases appeared in this group.

Group 5 (dark red, 61 mun./0.70%) includes municipalities with a high risk for the disease. These are densely populated that contrarily to a low ratio of children shows the highest positive change of population and also the highest socioeconomic deprivation. There are also above average ratio of agricultural business subjects and poultry.

The significantly different characteristics are within **Group 6** (light violet colour, 8 mun./0.01% of population) and **Group 7** (dark violet colour, 2 municipalities) that reported the lowest ratio of children in the population, and high incidence and relative risk for the disease. Groups differs mainly by socioeconomic deprivation, and ratio of agricultural business subjects. Both groups are very small comparing the previous 5 clusters, nevertheless, their dissimilarity is so significant that they created clusters.

	Overall (n = 6251)			Group1 (n = 2672)			Group 2 (n = 691)			Group 3 (n = 1942)		
	mean	sd	median	mean	sd	median	mean	sd	median	mean	sd	median
Population ages 0-14 (%)	15.2	3.2	15.2	15.0	3.6	15.1	**15.7**	3.1	15.6	15.4	2.6	15.3
Population density (people/km2)	91.6	142.7	52.0	53.2	48.1	39.1	**124.7**	184.8	70.7	118.5	138.9	69.6
Low education (%)	0.3	0.8	0.1	0.3	1.1	0.0	0.2	0.5	0.1	0.3	0.7	0.2
Population change (%)	109.5	25.5	105.3	108.1	17.6	105.3	115.8	40.3	107.7	110.1	30.0	105.1
Socioeconomic deprivation	**1.6**	0.2	1.6	**1.6**	0.2	1.6	**1.6**	0.2	1.6	**1.6**	0.2	1.6
Agricultural subjects (%)	7.4	7.4	5.2	8.3	7.6	6.3	10.6	9.8	7.5	5.4	5.6	3.7
Poultry (#/km2)	373.7	642.5	136.2	184.1	217.2	96.1	**1750.4**	1015.5	1439.1	179.8	211.9	98.3
Meat-processing subjects (#/1,000 people)	0.7	1.8	0.0	**0.7**	2.1	0.0	0.6	1.5	0.0	0.6	1.4	0.0
Average temperature (°C)	7.6	0.8	7.6	7.4	0.8	7.4	**8.1**	0.7	8.1	7.6	0.9	7.6
Flood risk areas (%)	1.2	2.0	0.0	1.0	1.9	0.0	1.1	2.0	0.0	1.3	2.1	0.2
Milk vending machines (#/1,000 people)	0.0	0.2	0.0	0.0	0.2	0.0	0.0	0.4	0.0	0.0	0.2	0.0
Disease events	15.8	161.4	2.0	1.1	3.9	0.0	23.7	331.0	2.0	16.4	41.9	5.0
Incidence (per 100,00 people)	672.4	1088.0	491.8	111.0	161.5	0.0	534.1	484.4	470.6	808.1	241.0	792.5
Relative risk (%)	0.7	1.1	0.5	0.1	0.2	0.0	0.6	0.5	0.5	0.9	0.3	0.8
	Group 4 (n = 875)			**Group 5 (n = 61)**			**Group 6 (n = 8)**			**Group 7 (n = 2)**		
	mean	sd	median	mean	sd	median	mean	sd	median	mean	sd	median
Population ages 0-14 (%)	15.0	2.6	15.0	13.6	3.7	14.0	9.1	5.4	8.1	9.6	0.9	9.6
Population density (people/km2)	123.2	242.1	61.3	100.9	172.8	42.0	19.9	9.6	17.5	17.8	2.7	17.8
Low education (%)	0.2	0.5	0.1	0.3	0.5	0.0	0.3	0.5	0.0	**0.5**	0.7	0.5
Population change (%)	107.2	15.5	104.4	**116.1**	47.6	105.6	97.7	15.7	102.0	90.1	2.5	90.1
Socioeconomic deprivation	**1.6**	0.2	1.6	**1.6**	0.2	1.6	1.5	0.3	1.5	**1.6**	0.1	1.6
Agricultural subjects (%)	6.6	6.4	4.8	9.4	10.0	5.9	3.2	5.9	0.0	**12.0**	2.8	12.0
Poultry (#/km2)	260.2	290.8	147.1	921.5	1093.6	495.9	104.6	224.9	0.0	366.3	82.1	366.3
Meat-processing subjects (#/1,000 people)	0.6	1.5	0.0	0.4	1.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average temperature (°C)	7.7	0.8	7.8	7.7	0.9	7.7	7.4	0.6	7.4	7.4	0.8	7.4
Flood risk areas (%)	1.3	2.1	0.0	1.4	2.1	0.1	**2.0**	3.3	0.6	0.0	0.0	0.0
Milk vending machines (#/1,000 people)	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Disease events	**51.7**	305.2	9.0	36.8	95.6	8.0	7.1	5.2	7.5	47.0	35.4	47.0
Incidence (per 100,00 people)	1765.8	501.7	1627.2	4151.2	1189.0	3972.1	11320.4	2717.7	11015.4	**39713.0**	8204.3	39713.0
Relative risk (%)	1.9	0.5	1.7	4.4	1.3	4.2	11.9	2.9	11.6	**41.8**	8.6	41.8

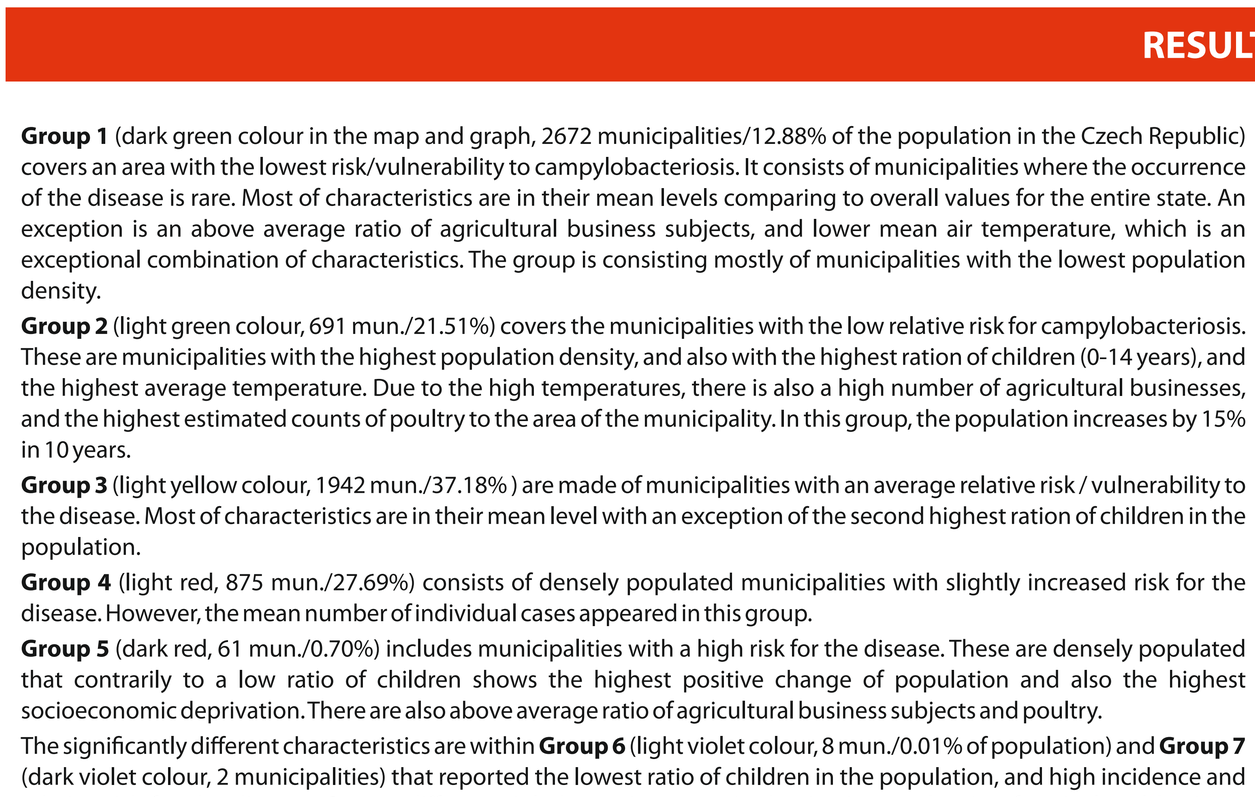

Fig. 6 Map of municipalities' membership to clusters

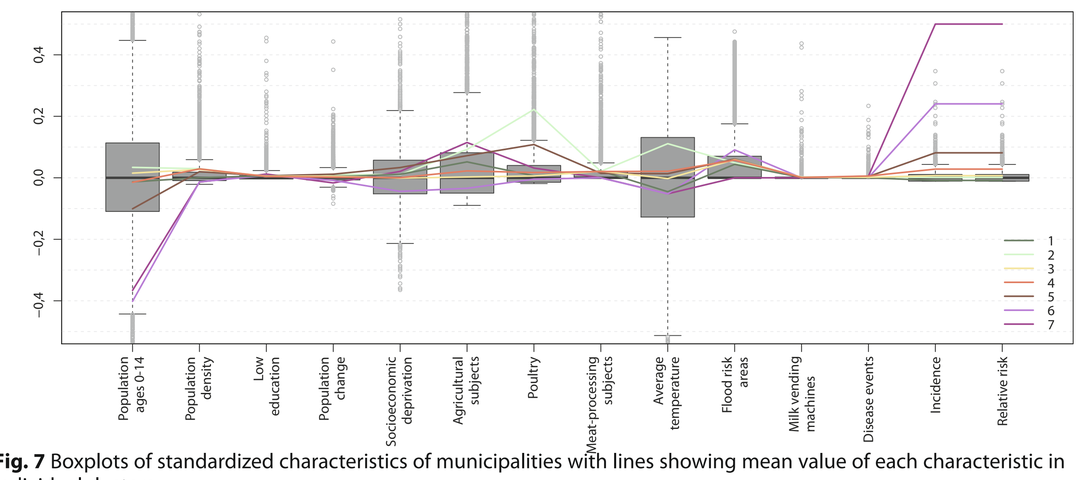

Fig. 7 Boxplots of standardized characteristics of municipalities with lines showing mean value of each characteristic in individual clusters